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AUTHOR Oerly, Diane
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ABSTRACT

Characteristics of a decision support system (DSS) and factors that influence system design are described, along with a decision support database at the University of Missouri-Columbia. Reasons that the institutional research office is in a unique position to support decision-making are identified. A review of the literature of DSS briefly covers three types of managerial activities: strategic decision-making, management control, and operation control. Each of these activities requires separate planning and control systems. Attention is directed to: decision theory and style, which is an important precursor to the design of a DSS; the proliferation of personal computers; the institutional environment (e.g., graduation requirements of different schools within the university); and the conversion of data into information. At UMC, the development of a departmental database (DDB) provided a mechanism for integrating the data from different sources into the information needed for strategic decision-making and control. One of the primary functions the DDB performs is to convert all data from operational systems to a single departmental structure. The contents and uses of the DDB are described. (SW)

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Decision Support: The Keys to Success

Diane Oerly

Assistant Director,

Institutional Research & Planning

University of Missouri-Columbia

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Ann K. Dickey, Chair
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Decision Support: The Keys to Success

ABSTRACT

With knowledge of the institution, its modes of decision making and the accessibility and validity of information, the institutional research office is in a unique position to support decision making. This paper reviews current literature on the characteristics of a decision support system and discusses the forces that influence a system's design. It provides an in-depth description of a working model of a decision support data base in a large, complex university including: methodology of design, implementation and modification, examples of usage and contributions, why it was a success and what has been learned in the process.

INTRODUCTION

As the higher education environment becomes increasingly competitive, the need for accurate, consistent and concise information for decision making increases. In many instances, the role of the office of institutional research is being expanded, and institutional researchers are experiencing an upsurge in requests for decision support.

One way an office of institutional research can contribute toward the accomplishment of this task is through a decision support data base. This paper provides a synopsis of the literature on decision support systems (DSS) and describes the creation and use of a successful decision support data base at a major land grant university. It describes the environment within the institution, and the conceptualization, development, and use of the Departmental Data Base.

THE IMPORTANCE OF PEOPLE

The prospects for improved design and use of management data bases in higher education are "severely limited by the short supply of people with the right combination of skills, intellect, insight, and experience," Jones concluded (1980, p. 50). He indicated that the information professional must have not only sophisticated data analysis skills, but must also possess the abilities to: 1) understand the management problem, 2) appreciate the decision makers' perspectives, and 3) ascertain and utilize the data that will best inform the decision maker. In essence, this information professional must be able to understand the perspectives of the decision maker, the analyst and the technician.

Keen and Morton (1978) also acknowledge the shortage of systems designers who possess both a technical competency and a capacity to understand the decision maker's world in order to provide the needed support. The human element is more important in decision support systems than in other forms of information systems because a DSS aims at organizational change by focusing on the effectiveness of decision making. While most information systems seek efficiency, effectiveness involves learning, adapting, and new ways of thinking. The individuals involved in design and implementation must serve as catalysts to spark and control this process. Quite often, the people are the most important ingredient in a successful DSS.

MANAGEMENT ACTIVITIES AND INFORMATION REQUIREMENTS

Managerial activities fall into three categories, according to Anthony (1965). Each activity is sufficiently distinctive to require separate planning and control systems:

- 1) Strategic decision making involves decisions on the goals and objectives of the organization, on the major allocation of resources to attain these objectives, and on the policies that govern acquisition and use of these resources.
- 2) Management control involves resources being used effectively and efficiently in the accomplishment of the organizations objectives.
- 3) Operation control involves specific tasks being carried out effectively and efficiently.

Based upon Anthony's categorization of management activities, Jones (1982) identified two distinct kinds of information systems: 1) operational, or transactional systems designed to support operational control or decision making. They are characterized by a focus on detail, with a premium being placed on the currency and accuracy of the data; and 2) management data bases designed to support strategic decision making which are typically updated less

frequently and are more aggregate than operational systems. Jones (1982, p. 34) indicated that

... the data bases and related information systems that support strategic decisions must be designed to produce information relevant to decisions that are unpredictable, as to both specific substance and timing. ... When output requirements for the information system are unpredictable and non-repetitive, the major design criteria become flexibility and ease of access, rather than speed and efficiency.

Jones also indicated that such systems must consist of aggregates rather than details, while simultaneously encompassing a broad scope. Since data come from various sources, systems design must focus on the interrelated ways in which it will be used.

DECISION THEORY AND ITS IMPLICATIONS FOR SYSTEMS DESIGN

Most of the literature agreed that an important precursor to the design of a successful decision support system is an awareness and understanding of decision theory and style. Chaffee (1983) as well as Keen and Morton (1978) provide informative and enlightening descriptions of different decision styles. Interestingly, they agree there are five types of decision makers, but describe and define them quite differently.

Indeed, it is important that the institutional researcher understand the varying approaches to decision making, the decision processes and the individual styles the DSS is supporting. It is vital that the designers of a decision support system understand the realities of the decision situation. However, much of the literature dismisses the actuality of multiple decision makers and the implications on the design of a system to support various decision styles and situations.

Higher education is somewhat unique in that all three kinds of management activity can be found at any level in the organization as Norris and Mims

(1984) discussed. Strategic planning is done by faculty members, department heads, and deans as well as chancellors and governing boards.

The risks of implementation failure and misuse of a DSS in an organizational environment containing multiple decision makers and conflicting goals were pointed out by Moore and Chang (1983). In higher education, in which strategic planning and decision making occur at several organizational levels, it is vital that all parties receive consistent information to avoid unnecessary confusion and misdirection. Thus, a successful DSS involves not only issues of design and support for a select number of individuals, but it also involves issues of dissemination of information to a potentially large number of people.

CHARACTERISTICS OF THE DSS SOLUTION

The decision support system is "an integrative, computer-based system to assist decision makers in using data and models to address semi-structured or unstructured problems or decisions that affect the organization's effectiveness," according to Norris and Mims (1984, p. 708). DSS systems should provide the administrator or manager with direct, flexible, and easy-to-use support for important non-routine problems and decisions. They are designed to enhance judgment, not replace it.

Jones (1982, p. 48) recommended the development of a

... general-purpose decision-support system that can respond to demands for a wide variety of information, often requiring unpredictable combinations of data. Precisely because the design cannot incorporate a predetermined set of analytic procedures and matching data that will meet all information requirements, it is more fruitful to design the system around a descriptive model of the college or university and its environment.

Decision Support Systems must be allowed to grow and evolve, according to Hurst, Ness, Gambino, and Johnson (1983). One must remain cognizant that the

decision is the goal, not the DSS. As the environment and decisions change so must the DSS. They recommended the "middle out" design approach of a prototype system designed to support a part of the overall problem, i.e., one that can be built and put to use quickly. This approach provides quick feedback on both the structure of the problem and the DSS. Further, they suggested a system that is synthesized, not analyzed. Unlike the systems analysis approach, in which a large task is broken down into manageable pieces, the systems synthesis approach involves tying together several separate components. As Hurst, et. al. (1983) describe it, a synthesized system is one created by taking a number of components "off the shelf" and combining them to form a crude approximation of a system. This process is similar to the engineer who, instead of designing and building the ultimate product with all the amenities, first connects existing components to arrive at a quick, verifiable solution.

THE PROLIFERATION OF PERSONAL COMPUTERS

Many authors have described how the availability of personal computers might affect the institutional research function and the providers of information for decision support. As Brinkman (1984, p. 24) pointed out, microcomputers may further confuse the decision making environment by helping increase the number of "detached, islandlike data bases." In an environment of decentralized computing and decision making it is imperative that efforts be made to assure all key decision makers are using the same data.

Personal computer users are quite different from the traditional mainframe users. According to Chachra (1984), this new user is someone who seeks a computing environment suited to the individual's personality, customized for the intended use. As the use of personal computers spreads throughout the organization, it becomes increasingly important that a flexible management data base be available and accessible to a variety of decision makers.

THE INSTITUTIONAL ENVIRONMENT

Data become information only in a context of use. The data analyst must understand the context in order to produce useful information. Likewise, a decision support data base must be designed within the context of the institutional environment in order to be effective.

The University of Missouri-Columbia (UMC) was founded in 1839 as the first state university west of the Mississippi River. Upon passage of the Morrill Act in 1862 UMC became a land-grant institution. A four campus system was created in 1963, with campuses in Columbia, Kansas City, St. Louis and Rolla. The University of Missouri-Columbia, with a Fall 1985 enrollment of over 23,000 students, ranks among the nation's top 20 in enrollment.

UMC is comprised of the following Schools or Colleges: Agriculture, with its School of Forestry, Fisheries and Wildlife, Arts and Sciences, Business and Public Administration, with its School of Accountancy, Education, Engineering, Extension, Graduate, Home Economics, Law, Library and Information Science, Journalism, Medicine and Health Related Professions, Nursing, Public and Community Services, including Social Work, and Veterinary Medicine. In many ways each of these schools/colleges has a great deal of autonomy. For example, each sets its graduation requirements and many have additional requirements for admission.

One of the major factors influencing the design of a decision support data base is the approach to decision making being employed within the institution. As Kaludis anticipated in 1973, UMC has responded to these times of fiscal constraint by decentralizing the budget process and various other kinds of decision making in order to afford the academic and administrative managers maximum flexibility in the utilization of resources. For example, unit managers rather than central campus administration are now responsible for the disposition of year-end funds. Of course, the decision makers in each of the schools and

colleges have their own decision style and differing desires and needs for information.

THE DATA ENVIRONMENT

Generating information to support decision making typically starts with the conversion of data into information. The distinction between data and information was explained by Jones (1982). Data are the raw materials from which information is created. The quality of data is related to its accuracy, validity and reliability. Information is created when data are synthesized and compiled in order to convey to the recipient some practical knowledge. Information's quality depends upon relevance, timeliness and acceptability.

In order to supply information to support decisions, one must begin with good data which comes from good operational computer systems. Here at UMC, we are fortunate to have among the best administrative information systems found in higher education. Our Payroll/Personnel system is our newest data base. It was purchased from Integral Systems, Inc. and was implemented in July, 1981. The Financial Accounting System (FAS) was purchased from Information Associates, and implemented in July, 1980. The third major system in use is our Student Information System (SIS). It was purchased from System and Computer Technology Corp., implemented in July, 1975, and has undergone extensive modifications and enhancements to the point where one would find it almost unrecognizable. SIS is fully integrated into student accounts payable, receivable, and the Student Aids Management (SAM) system. The most recent improvement was the addition of on-line registration capabilities in Fall, 1985.

These systems, designed for operational and management control, are fulfilling those needs quite well. However, until the development of the Departmental Data Base (DDB), there existed no mechanism for integrating the data from these sources into the information needed for strategic decision making and control.

THE FROZEN FILE ENVIRONMENT

While operational control decisions need current data, a vital ingredient of an information system designed to support strategic decisions is the consistency of response provided by a frozen file. If a question is raised, it is important that the response be the same whether it is asked last month, last year, or tomorrow. Changing answers only distract the decision maker from the task at hand. While there is wide acceptance of a frozen student file as of a given census date, many administrators believe they need up to the minute data on expenditures or payroll commitments. This is indicative of the confusion between informational needs for operational versus planning decisions. Since the same individual often makes both kinds of decisions simultaneously, this confusion is understandable. It is important, however, that the user of a strategic decision support data base understands and appreciates the difference.

CHRONOLOGICAL PERSPECTIVE OF THE DATA BASE

Perhaps the most important point one can make about the design of a decision support data base is that it is an evolutionary process. It is through the conceptualization, design, and implementation of the data base that decisions are studied, understood and supported. The data base is secondary to the awareness gained through the design process. As time passes the DDB will change, just as the decisions facing our institution will change.

The DDB was conceptualized by an interim Dean of Arts and Sciences. Faced with very severe financial constraints, he needed to arrive at retrenchment decisions. This individual had years of experience in academic administration and knew the kinds of descriptive data he needed to compare the departments within the college: outcome measures of credit hours, enrollments and degrees; as well as inputs in the form of dollars and people. Rather than try to gather the data separately from the more than twenty-five departments and deal with varying assumptions and levels of subjectivity, this individual sought the

assistance of the Office of Institutional Research and Planning.

Initial discussions of the file began in early March of 1982, and the files were essentially implemented within a month. This speed of design and implementation would not have been possible without the investment the institution had already made in the form of file design and a library of programs and formats to convert the operational data bases into management information. All the operational system frozen files had been converted to SAS data sets and longitudinal comparisons were already being done. Numerous batch SAS programs were in existence, providing a wide variety of reports. Another important ingredient was that our Chancellor has been deeply involved in the creation of the office of institutional research. We have had the benefits, as McCorkle (1977) described, of having top management govern the type of information assembled and how it should be used. The DDB has been in use for four years, and has stood the test of time to emerge as a valuable, easily communicated and frequently utilized data base.

INTERRELATING DATA FROM DIFFERENT SYSTEMS

One of the primary functions the DDB performs is to adjust for the different organizational structures of the operational data bases. Each operational system stands alone and is based on departmental structures which are inconsistent with other systems. The DDB converts all the data from the operational systems to a single departmental structure. In the design of the system we chose to use the departmental structure of the Financial Accounting System as our fundamental unit. Since these departments are the basic units for the allocation of resources, they are relevant to strategic planning and are easily recognized. Aggregation at the departmental level provides sufficient detail on decision units of concern to the dean of a school or college. The departmental detail can then be easily summarized to school/college levels to meet the needs of the Provost or Chancellor.

The DDB employs consistent and standard definitions which the user should understand. However, it does not require the user know the myriad of details that would be required to obtain comparable information from the operational data base. For example, if the user were interested in obtaining data on admissions test scores of first time freshmen from the operational data base he/she would not only have to understand the hierarchical structure of the student information system, but also the multiple combinations of characteristics which define a first time freshmen and the four different admissions tests possible. Additionally, the user would have to know how these tests can be equated using a table of "Missouri Standard Scores" and, of course, what to do in the case of multiple scores for an individual. By placing the definitions in the background the DDB allows the user to concentrate on the problem at hand rather than the data. As Moore and Greenwood (1984, p. 1) indicated, "the objective of a decision support system is to involve the manager or decision maker in the decision-analysis process while simultaneously relieving that person of the burden of developing and performing detailed analyses."

One must give serious consideration to information dissemination when attempting to support multiple strategic decision makers in a decentralized, personal computing environment. Selecting the appropriate level of aggregation is perhaps the best way to avoid misunderstanding and misuse of the data. A major obstacle is the need to convey an understanding of the information and underlying definitions.

We have found the departmental data base to be a workable model because, while it relies heavily on the various institutional definitions in its creation, it does not require that the user understand the various intricacies of the definitions and how to employ them to get meaningful data from the various "corporate data bases." It is important to select the recognizable and understandable unit, the department, and to utilize standard measures of output

(degrees, credit hours and headcount enrollments) and input (expenditures and personnel). By relying on standard measures and an easily recognizable organizational structure, we avoided many potential definition problems. "Inconsistent internal information and divergent external data bases may with the best of intentions be used to generate models that are inaccurate or inappropriate," according to Jedamus (1984, p. 82). The departmental data base was created to facilitate consistency in the data used by all levels of administration. Perhaps even more importantly, it has served to facilitate communication and coordination among decision makers at various levels in the organization.

CONTENTS AND DESCRIPTION OF THE DATA BASE

The Departmental Data Base, was created to help convert operational data into planning information. It is a conversion from systems designed to automate major operational functions (such as recording student schedules, transcripts and demographic data), where machine efficiency is a prime concern, into flexible, easy to use data files designed to respond to ad hoc ever-changing user needs and demands.

Incorporated in the data base are the following frozen files: Student Information System (SIS) as of the fourth week of the fall semester, Payroll/Personnel System files as of October 31, and year-end Accounting System files after the completion of auditing, i.e., the exactly same data as reported in the official financial statement.

The departmental data base exists on the mainframe computer utilizing the Statistical Analysis System (SAS). It is available for on-line query via SAS's full screen editor enhanced by selection menus. There are also menus from which one simply selects the level of aggregation, organizational unit, and type of data desired in order to create a file ready to import into Lotus 1-2-3 or Symphony.

Several years of data based on consistent definitions are provided for

longitudinal comparisons. It is organized into several subject areas, with each subject partitioned into a member of a SAS data set. The members are as follows: student credit hours, headcount enrollments, degrees conferred, admissions test scores, faculty and staff FTE, and expenditures.

Perhaps the easiest way to understand the contents of the DDB is to envision a two dimensional array with the columns being years, and the rows being types of data. For example, in the degrees conferred file, the columns are fiscal years and the rows are types of degree, e.g., bachelors, masters, doctoral, etc. A record exists for each department, and it contains variables whose names indicate the particular type of data and the time period. For example, the variable BCHDEG84 from the Degrees Conferred file contains the number of bachelors degrees awarded for the 1983-84 fiscal year.

Detailed descriptions of each member of file are as follows:

- Student credit hours generated are by level of enrollment (freshman, sophomore, junior, senior, masters, education specialist, doctoral, medicine, law and veterinary medicine) for each fall from 1977 through 1985.
- Full time equivalent students are not maintained as separate entities, but are instead calculated from credit hours for reports or for downloading.
- Headcount enrollments are by student level (see credit hours above) for each fall from 1977 through 1985.
- Standardized admissions test scores are recorded as the percentage of students in each quartile and in the upper and lower 10% for both first time freshmen and upper division (juniors and seniors) for each fall from 1979 through 1985. Since some schools or colleges do not admit first time freshmen, comparisons can be made on upper division students.

- Degrees conferred are by type of degree (bachelors, masters, first professional and doctoral) for fiscal years 1975-76 through 1984-85.
- Expenditures are reported by type of expense. Salaries and wages expenses are reported by occupational grouping (see faculty and staff FTE below), and other expenses are reported as staff benefits, computer, equipment, and other. Also, expenses are reported by type of fund: general operating and total. Actual expenditures are reported for all years since the inception of the current accounting system (1980-81 through 1984-85). Budgeted general operating expenses were included for 1975-76 through 1980-81.
- Faculty and staff FTE are reported by occupational grouping (Professor, Associate Professor, Assistant Professor, Instructor, Graduate Research and Teaching Assistants, Other Teaching Staff, Executive and Administrative, Professional, Technical, Office and Clerical, Crafts and Trades, and Service and Maintenance). The file includes actual FTE for general operating instructional, total general operating, and all funds as of October 31 for the years since the inception of the current system, 1981 through 1985. Budgeted general operating FTE is available for fiscal years 1975-76 through 1980-81.

When the DDB was originally designed, budgeted data were included so that five year trends for expenditures and faculty and staff FTE could be reported. Since five years of actual data are now available, the budgeted FTE and expenditures are rarely used.

HOW THE FILES ARE UPDATED/MAINTAINED

Each fall after we have received the "snapshots" of the official files frozen as of census dates, we execute a computer program which summarizes the unit records and, if necessary, performs the crosswalk from the student system

departmental structure to the accounting department structure and updates the departmental data base. Because of the variable naming conventions, the programmer simply makes mass changes of all year references in the program, for example all "84s" are changed to "85s" with a single command before submitting the program. There is a separate program for each subject area, which prints several verification reports. For example, the headcount enrollment update program prints reports of numbers of students by both organizational structures (accounting and student department). This permits us to easily reconcile any differences between enrollment reports from the Registrar and those produced from the DDB.

Once the file has been updated, it can be viewed using SAS full screen product or it can be downloaded using a series of ISPF panels. Also, hardcopy reports can be prepared for easy reference.

USES OF THE DEPARTMENTAL DATA BASE

Having been in use for four years now, this decision support system has stood the tests of time and multiple applications to emerge as a valuable, easily communicated and used data base. The Departmental Data Base has successfully performed several of the contributions to planning, decision making and policy formulation identified by Saupe (1981) including:

- Facilitate self-study and accreditation review. Several different reports and analyses have been conducted in compressed time frames to meet the informational needs of the state higher education coordinating agency, a system-wide long range planning process, our decennary campus-wide accreditation review as well as several accreditation reviews of individual schools and colleges.
- Provide relevant factual evidence to support intensive reviews of programs or departments. Information from the DDB, coupled with peer comparisons afforded by institutional data exchange information, is used extensively by the

Dean of Arts and Sciences in on-going efforts to understand the environments of his twenty-five departments, how they compare with each other, and with peer institutions. Among other things, the information has proved valuable in decisions on faculty and teaching assistant staffing patterns and the discontinuance of course offerings

- Assist in the identification of inefficiencies in the allocation of resources and in instructional activities. The Dean of the College of Agriculture has made extensive use of information from the DDB to perform ratio analyses of expenditures per faculty member, degrees conferred, and other measures in order to determine whether adjustments are needed in the allocation of expense and equipment allocations to adjust for changing enrollments. Also, our library has used DDB information in it's model to determine changes needed in acquisition patterns to adjust for changes in enrollments.

FUTURE DIRECTIONS

The Departmental Data Base continues to evolve and change. Comparisons with peer institutions is the type of data that is most often coupled with the data on our institution supplied by the DDB. One of our future emphases will be on combining the files from several years of institutional data exchange into a single data base and making it available to be downloaded to one's personal computer.

As part of the evolutionary process of the DDB, we are currently in the process of increasing the level of detail of data available on expenditures. While the DDB supplies adequate data on salary and wage expenditures we are finding the user needs additional detail on expense and equipment expenditures and needs additional breakouts by type of fund, e.g., service operations and auxiliaries, gifts, grants and contracts, etc.

How to facilitate the use of the DDB information in graphic form is another area we are exploring. While the data can now be downloaded easily

through a series of menu screens and then displayed in graph form at one's personal computer, we hope to enhance the graphic capabilities in the future. We recognize the ability of a visual display to further user comprehension and understanding, and are continuing to investigate alternatives.

CONCLUSION

As Jones (1982, p. 45) pointed out, "a management data base may be an illuminating beacon, or it may be a perverse cornucopia, spewing out indigestible numbers." In order to support strategic decision making at various levels in the organization, and to assure that all parties have access to consistent information, we have created a data base of descriptive characteristics of departments designed to be flexible and easy to use.

We have found the key elements in the design of a decision support or management data base to be:

1. Consistent, widely understood and accepted definitions.
2. Time series analyses to provide the necessary perspective a snapshot of data cannot.
3. Flexibility in level of aggregation, format and presentation.
4. The capacity to alter on demand the interrelationships of the data.
5. Timely response to needs for data -- to support the decision the data must be available before the decision is to be made. This often dictates an hour or two response time.

The Departmental Data Base has evolved into a working model of a management data base which supports unstructured, strategic decision making when employed directly by the user as well as when employed by the office of institutional research on the user's behalf.

REFERENCES

- Bacchetti, R.F. (1977). In Praise of Good Questions. In Carl R. Adams (Ed.), Appraising Information Needs of Decision Makers, New Directions for Institutional Research, 15, 11-18.
- Brinkman, Paul T. (1984). The Changing Nature of Computer-Based Information Systems. In William L. Tetlow (Ed.), Using Microcomputers for Planning and Management Support, New Directions for Institutional Research, 44, 11-26.
- Chachra, Vinod (1984). Micros, Minis and Mainframes. In William L. Tetlow (Ed.), Using Microcomputers for Planning and Management Support, New Directions for Institutional Research, 44, 63-76.
- Chaffe, E.E. (1983). Rational Decisionmaking in Higher Education. Boulder, CO: NCHEMS.
- Hurst, E. Gerald, Ness, David N., Gambine, Thomas J., and Johnson, Thomas H. (1983). Growing DSS: A Flexible, Evolutionary Approach. In Bennett, J.L. (Ed.), Building Decision Support Systems. Reading, Mass.: Addison - Wesley.
- Jedamus, Paul (1984). The Case for Decision Support Management. In William L. Tetlow (Ed.), Using Microcomputers for Planning and Management Support, New Directions for Institutional Research, 44, 77-86.
- Jones, D.P. (1982). Data and Information for Executive Decisions in Higher Education. Boulder, CO: NCHEMS.
- Keen, P.G.W. (1982). Decision Support Systems: Lessons for the 80s. EDUCOM Bulletin, 17-21.
- Keen, P.G.W. and Morton (Fall, 1978). Decision Support Systems: An Organizational Perspective. Reading, Mass.: Addison - Wesley.
- Kaludis, George (1973). Emerging Principles for Budgeting. In George Kaludis (Ed.), Strategies for Budgeting, New Directions for Institutional Research, 2, 97 - 102.
- Masland, A.T. (1984). Integrators and Decision Support System Success in Higher Education. In Charles F. Elton (Ed.), Research for Higher Education, 2, 211 - 234.
- McCorkle, C.O. (1977). Information for Institutional Decision Making. In Carl R. Adams (Ed.), Appraising Information Needs of Decision Makers, New Directions for Institutional Research, 15, 1 - 9.
- Moore, L.M. & Greenwood, A.G. (Summer, 1984). Decision Support Systems for Academic Administration. AIR Professional File #18.
- Norris, Donald M. & Mims, R. Sue (Nov-Dec, 1984). A New Maturity for Institutional Planning and Information Management. Journal of Higher Education, 700 - 718.
- Saupe, Joe L. (1981). The Functions of Institutional Research. Tallahassee, Fl: Association of Institutional Research.
- Sheehan, B.S. (1984) Measurement for Decision Support. In Charles F. Elton (Ed.), Research for Higher Education, 2, 193 - 210.
- Tetlow, W.L. (1984). The Second Wave of Campus Computerization. In William L. Tetlow (Ed.), Using Microcomputers for Planning and Management Support, New Directions for Institutional Research, 44, 5 - 10.